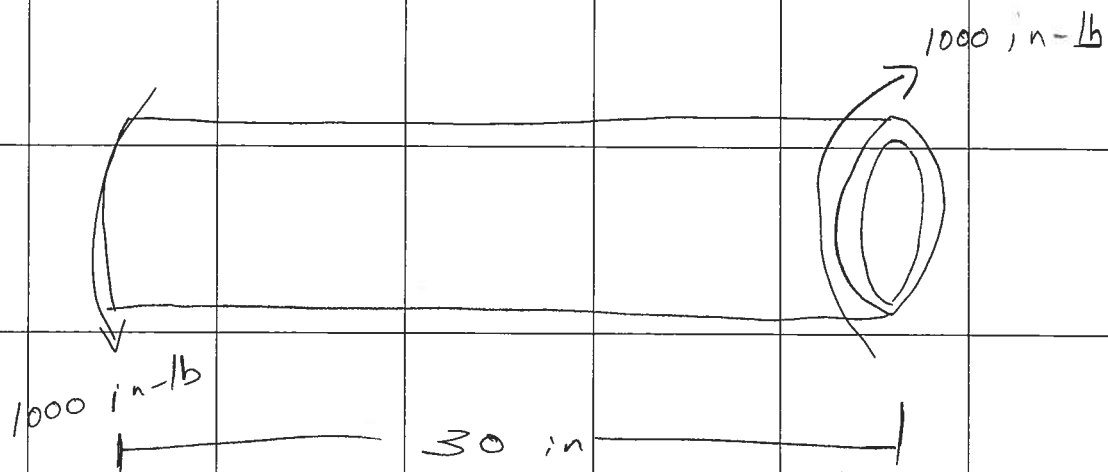


A hollow steel shaft is subjected to a torque of 1000 in-lb as shown.

The shaft has a length of 30 in, an outer diameter of 2 in, and an inner diameter of 1.75 in as shown. Calculate the angle of twist of the shaft and the magnitude of the maximum shearing stress in the shaft.



Assume $G_{stl} = 11 \times 10^6$ psi

First Calculate I_P

$$I_P = \frac{\pi}{2} (r_o^4 - r_i^4) = \frac{\pi}{2} \left(\left(\frac{2}{2} \right)^4 - \left(\frac{1.75}{2} \right)^4 \right) \quad (1)$$

$$\underline{I_P = .650 \text{ in}^4} \quad (2)$$

Angle of twist

$$\phi = \frac{T L}{I_P G} \quad (3)$$

$$\phi = \frac{(1000 \text{ in-lb})(30 \text{ in})}{(.650 \text{ in}^4)(11 \times 10^6 \frac{\text{lb}}{\text{in}^2})} \quad (4)$$

$$\phi = 4.196 \times 10^{-3} \text{ radians} \quad (5)$$

Maximum Shearing Stress

$$\tau_{\max} = \frac{T r}{I_P} \quad (6)$$

$$\tau_{\max} = \frac{(1000 \text{ in-lb})(1 \text{ in})}{(.650 \text{ in}^4)} \quad (7)$$

$$\tau_{\max} = 1538 \frac{\text{lb}}{\text{in}^2} \quad (8)$$